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NATIONAL DAM SAFETY PROGRAM. LAKEWOOD (EAST) DAM (MO 20373), MI--ETC(U)
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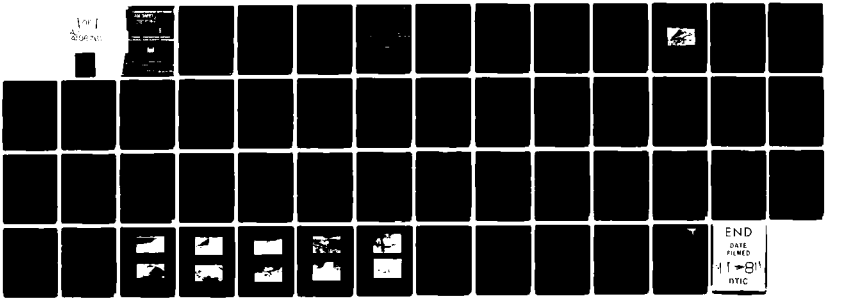

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

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National Dam Safety Program. Lakewood (East) Dam (MO 20373), Missouri - Kansas City Basin, Jackson County, Missouri. Phase I Inspection Report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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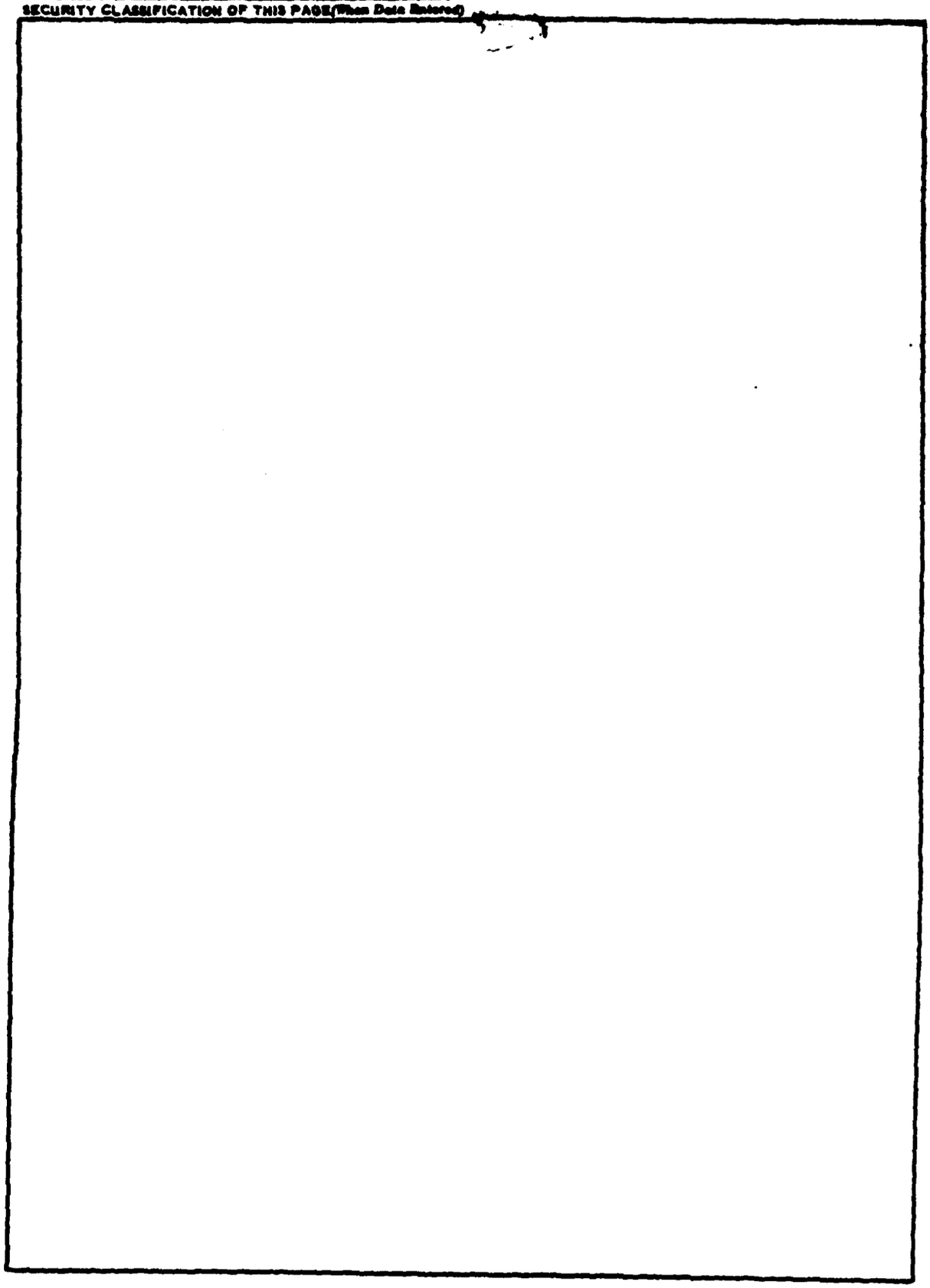

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MISSOURI-KANSAS CITY BASIN

LAKEWOOD (EAST) DAM
JACKSON COUNTY, MISSOURI
MO. 20373

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

AUGUST 1978

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: Lakewood (East) Lake Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Lakewood (East) Lake Dam. It was prepared under the National Program of Inspection of Non-Federal Dams.

SUBMITTED BY: SIGNED
Chief, Engineering Division

31 JAN 1979
Date

APPROVED BY: SIGNED
Colonel, CE, District Engineer

1 FEB 1979
Date

LAKEWOOD (EAST) LAKE DAM

JACKSON COUNTY, MISSOURI

MISSOURI INVENTORY NO. 20373

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY:

BLACK & VEATCH
CONSULTING ENGINEERS
KANSAS CITY, MISSOURI

UNDER DIRECTION OF

ST. LOUIS DISTRICT, CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

AUGUST 1978

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	Lakewood (East) Lake Dam
State Located	Missouri
County Located	Jackson County
Stream	West Fork of May Brook
Date of Inspection	8 August 1978

Lakewood (East) Lake Dam was inspected by a team of engineers from Black & Veatch, Consulting Engineers for the St. Louis District, Corps of Engineers. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers and developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, this dam is classified as an intermediate size dam with a high downstream hazard potential. According to the St. Louis District, Corps of Engineers the estimated damage zone extends 20 miles downstream of the dam. Within the first mile of the damage zone are six homes and the bridge of one improved road. The flood plain is farmed.

Our inspection and evaluation indicate the spillway does meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The spillway will pass the probable maximum flood without overtopping. Considering the volume of water impounded and the proximity of six homes and a bridge, the probable maximum flood is the appropriate spillway design flood.

Deficiencies visually observed by the inspection team were erosion on the downstream embankment slope, seepage at the right abutment, and excessive growth of small trees and weeds along the downstream embankment slope. Seepage and stability analyses were not available for this dam. To satisfy the requirements of the guidelines, seepage and stability analyses should be on file for dams in the High Hazard classification.

There were no observed deficiencies or conditions existing at the time of the inspection which indicated an immediate safety hazard. Future corrective action and regular maintenance will be required to prevent further erosion on the embankment which could lead to the development of potential safety hazards. A detailed report discussing each of these deficiencies is attached.

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Harry L. Callahan
Harry L. Callahan, Partner
Black & Veatch

OVERVIEW OF DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LAKEWOOD (EAST) LAKE DAM

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SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the District Engineer of the St. Louis District, Corps of Engineers, directed that a safety inspection of the Lakewood (East) Lake Dam be made.

b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed with the help of several Federal agencies and many State agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) The dam is a rolled earth structure located in the valley of the West Fork of May Brook in central Jackson County, Missouri (see Plate 1). A roadway has been constructed across the top of the dam. Topography of the contributing watershed is characterized by rolling hills. Land use consists of residential areas and farm land. Topography in the vicinity of the dam is shown on Plate 2. Lakewood Lake is located to the west of Lakewood (East) Lake. The two lakes are connected by a 110 feet wide boat channel, 15 feet deep at normal pool elevation (El.858.0). Lakewood Lake shall be referred to as Lakewood (West) Lake in this report.

(2) An emergency spillway channel was excavated within the limestone strata in the north abutment. The roadway crossing the dam continues across the emergency spillway as a low water crossing (see Plate 7).

(3) A drop inlet spillway is located 80 feet upstream from the centerline of the road across the dam near the north abutment. The drop inlet is a 10.5 by 15.0 feet vertical concrete box with two 13.75 feet wide openings normal to the longitudinal axis of the dam at El.858.0. The drop inlet is connected to a 5 by 6 feet discharge culvert which discharges at El.808.8, then drops 34 feet to the stilling basin and downstream channel (see Plate 6).

(4) A drainage blanket was detailed as constructed along an area beginning 34 feet downstream from the centerline of the dam extending 124 feet downstream for the entire length of the dam (see Plate 5). An 8 inch perforated asbestos bonded corrugated metal pipe was shown embedded in the 8 feet thick drainage blanket at 1 foot above the bottom of the blanket. Three 12 inch asbestos bonded corrugated metal pipes extend from the perforated pipe to the downstream toe of the dam.

(5) A 30 inch sewer line runs through the embankment normal to the longitudinal axis of the dam approximately 290 feet south of the drop inlet centerline.

(6) A 12 inch water main is buried parallel to the longitudinal axis of the dam near the downstream side of the roadway on top of the dam.

(7) Pertinent physical data are given in paragraph 1.3.

b. Location. The dam is located in the central portion of Jackson County, Missouri, as indicated on Plate 1. The lake formed by the dam is shown on the United States Geological Survey 7.5 minute series quadrangle maps for Blue Springs and Lake Jacomo, Missouri in Sections 5, 6, 7, and 8 of T48N, R31W.

c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. Based on these criteria, the dam and impoundment are in the intermediate size category.

d. Hazard Classification. The hazard classification assigned by the Corps of Engineers for this dam is as follows: The Lakewood (East) Dam has a high hazard potential, meaning that the dam is located where failure may cause loss of life and serious damage to homes; agricultural, industrial and commercial facilities; important public utilities; main highways or railroads. The Lakewood (East) Lake Dam has an estimated damage zone which extends 20 miles downstream of the dam. Within the first mile of the damage zone are six homes and one improved road bridge. The flood plain is farmed.

e. Ownership. The dam is owned by Farm and Home Savings Association of Nevada, Missouri, 217 Bayview, Lee's Summit, Missouri 64063.

f. Purpose of Dam. The dam forms a 110 acre recreational lake (from design calculations).

g. Design and Construction History. The dam was designed primarily by the late Robert J. Spiegel, Consulting Engineer, Kansas City, Missouri. Construction began in 1970 by Andes and Roberts Construction Company, Independence, Missouri under the supervision of E. Daniel Weiskirk, P.E. Impoundment of water began in 1973. The boat channel between the west and east lakes was opened in 1975.

h. Normal Operating Procedure. Normal rainfall, runoff, transpiration, evaporation, and seepage through the natural limestone and shale abutment of the west dam all combine to maintain a relatively stable water surface elevation.

1.3 PERTINENT DATA

a. Drainage Area - Combined drainage area of Lakewood (West) Lake and Lakewood (East) Lake is 3,410 acres (2,210 acres, Lakewood (West) Lake and 1,200 acres, Lakewood (East) Lake).

b. Discharge at Damsite.

(1) Normal discharge at the damsite is through the drop inlet spillway.

(2) Estimated experienced maximum flood at damsite - unknown.

(3) Estimated ungated spillway capacity at maximum pool elevation - 19,600 cfs (El.868.3).

c. Elevation (Feet Above M.S.L.).

(1) Top of dam - 870.3 ± (see Plate 3)

(2) Spillway crest - 859.0 (West dam box culverts), 858.0 (East dam drop inlet)

(3) Streambed at centerline of dam - 773.±

(4) Maximum tailwater - unknown.

d. Reservoir. Length of maximum pool - 6,200 feet ±

e. Storage (Acre-feet).

(1) Top of dam - 4,810 (from design calculations for east dam); 10,120 (for total of east and west lakes)

(2) Spillway crest - 2,800 (from design calculations for east lake only); 5,943 (for total of east and west lakes)

(3) Design Surcharge - 4,100 (from design calculations for east lake only) 7,640 (for total of east and west lakes)

f. Reservoir Surface (Acres).

(1) Top of dam - The combined reservoir surface area of Lakewood (East) Lake and Lakewood (West) Lake is 440 acres (210 acres, east lake and 230 acres, west lake)

(2) Spillway crest - The combined reservoir surface area of Lakewood (East) Lake and Lakewood (West) Lake is 235 acres (110 acres, east lake and 125 acres, west lake)

g. Dam.

(1) Type - rolled earth embankment

(2) Length - 1,300 feet

(3) Height - 95 feet maximum

(4) Top width - 60 feet

(5) Side Slopes - varies (see Plate 5)

(6) Zoning - Composed of impervious core supported by random fill on both faces (see Plate 5).

(7) Impervious Core - Vertically extends throughout the entire height of the dam with a 20-foot top width and 3 to 1 side slopes (upstream face) and 0.5 to 1 side slopes (downstream face) (see Plate 5).

(8) Cutoff - approximately 25 feet wide with 1:1 side slopes (see Plate 5)

(9) Grout curtain - unknown.

h. Diversion and Regulating Tunnel - none.

i. Spillway.

(1) Type - concrete drop inlet (see paragraph 3.1c)

(2) Length of weir - 27.5 feet (see paragraph 3.1c)

(3) Crest elevation - 858.0 feet m.s.l. (East dam drop inlet)
859.0 feet m.s.l. (West dam box culverts)

(4) Gates - none.

(5) Upstream Channel - none.

(6) Downstream Channel - Discharge from the drop inlet discharge culvert falls to a stilling basin excavated from the limestone and shale strata near the downstream toe of the embankment. The discharge channel extends 295 feet downstream of the stilling basin at a 0.5% slope. The channel then drops on an incline of 11.0 feet (horizontally) to 5.8 (vertically) to the invert of four 42 inch corrugated metal pipes (Inv. El.773.5) under Bowlin Road. Flow from the culverts enters the remaining

500 feet of the excavated discharge channel, then joins with the natural downstream channel.

j. Regulating Outlets - The east lake could be lowered to the invert elevation of the boat channel (El.843.0) by use of the outlet provided in the west dam. The west dam outlet is a 36 inch diameter reinforced concrete pipe with a wall thickness of 5-3/4 inches. A 36 inch diameter Rodney Hunt Series HY-Q-280 sluice gate is provided with an 80.5 feet seating head. The pipe invert elevation is 781.0. An outlet structure is provided with an operator at El.868.0.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Design data was made available by Andes and Roberts Construction Company and Earl C. Meserve, P.E. The data included design and as-built drawings, hydraulic and hydrologic calculations, and post-construction inspections and seepage flow records.

2.2 CONSTRUCTION

The dam was constructed in 1970 and 1971 by Andes and Roberts Construction Company of Independence, Missouri. As-built drawings and data were obtained from Andes and Roberts Construction.

2.3 OPERATION

The maximum recorded loading on the dam is unknown. Several post-construction studies have been performed since the impounding of water began. In the winter of 1976 seepage measurements were undertaken by Earl C. Meserve and continued through much of 1977. Records were made of seepage through both the East and West dams. During the period of May through September, 1977 a water balance study was conducted by Woodward-Clyde Consultants, Kansas City, Missouri. A visual inspection of the dam and review of available data was performed subsequent to the above study by Woodward-Clyde.

2.4 EVALUATION

a. Availability. Engineering data in the form of background reports, as-built drawings, and construction records were available from Andes and Roberts Construction Company and Earl C. Meserve, P.E. No other engineering data were found.

b. Adequacy. The engineering data available were inadequate to make a detailed assessment of design, construction, and operation. Seepage and stability analyses necessary to satisfy the requirements of the guidelines were not available.

c. Validity. The engineering data available were insufficient to determine the validity of the design, construction, and operation.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of Lakewood (East) Lake dam was made on 8 August 1978. The inspection team included professional engineers with experience in dam design and construction, hydrologic - hydraulic engineering, and geotechnical engineering. Specific observations are discussed below. No observations were made of the condition of the upstream face of the dam below the pool elevation at the time of the inspection.

b. Dam. The inspection team observed the following items at the dam. An erosion ditch has formed at the downstream toe of the embankment running from the dam centerline westward toward the left abutment. Erosion due to surface runoff was observed along the entire length of the downstream toe of the embankment. Seepage was observed at the junction of the riprap on the downstream embankment face adjacent to the stilling basin and right abutment of approximately 2 gpm. The inspection team was unable to ascertain that seepage was actually passing through the embankment. Excessive growth of small trees and weeds along downstream slope was observed. No evidence of sliding, cracking, or settlement of the embankment was observed at the time of inspection. The outlets for the dam's internal drainage system could not be inspected due to vegetal growth hindering location of the outlets.

c. Appurtenant Structures. The west dam spillway consists of a concrete-lined approach channel with twelve 11 by 6 feet concrete box culverts which provide the support for the roadway over the spillway. Twelve 11 by 1 by 1 foot blocks increase the flow level through the culverts by 1 foot. No water was discharging through the west dam outlet culvert at the time of inspection. The west dam outlet works sluice gate operator could not be checked for operation because it was locked. A 10.5 by 15.0 feet concrete drop inlet structure permits discharge from the east lake at El.858.0 which is 1 foot lower than the invert of the 12 box culverts at the west spillway (El.859.0). Flow entering the drop inlet discharges through a 6 by 5 feet inlet discharge culvert to a stilling basin near the downstream toe of the east dam. An emergency spillway channel is provided on the east dam across the road (El.862.0). Flow from the east reservoir must pass through either the drop inlet or the boat channel. The drop inlet and emergency spillway appear in good condition. A 30-inch gravity sewer is located approximately 290 feet south of the drop inlet of the east dam. The sewer, reportedly, may be shut off by using a valve located on the upstream face of the dam. The valve was not observed at the time of inspection.

d. Reservoir Area. No slides or excessive erosion due to wave action were observed along the shore of the reservoir.

e. Downstream Channel. Heavy vegetation and mild channel slopes typical of streams in the area characterize the channel downstream of the spillway. A wooden wall at the crest of the incline immediately upstream of Bowlin Road retains water to a depth of approximately 4 to 5 feet in the discharge channel and stilling basin. Seepage was noted at various locations between the Ladora Shale layers.

3.2 EVALUATION

Items observed in the visual inspection which need to be monitored are seepage at the right abutment and erosion of the downstream toe of the embankment. These items if left uncontrolled could lead to further deterioration of the embankment integrity resulting in an increased potential of failure.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The pool is primarily controlled by rainfall, runoff, evaporation, seepage through the natural limestone and shale abutment of the west dam, and capacity of the uncontrolled spillway. A staff gage and recorder are operable.

4.2 MAINTENANCE OF DAM

Maintenance performed was unknown.

4.3 MAINTENANCE OF OPERATING FACILITIES

No operating facilities exist at this dam. The outlet structure at the west dam shows no evidence of maintenance.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

The inspection team is not aware of any existing warning system for this dam.

4.5 EVALUATION

Seepage at the right abutment along with erosion and vegetation on the downstream slope increase the potential for failure and warrant regular monitoring and control.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. Report and as-built drawings were available. Design calculations were available for hydrology and hydraulics.

The embankment and appurtenant structures were designed primarily by Robert J. Speigel, Consulting Engineer. The hydraulic and hydrologic computations were performed by Earl C. Meserve, Consulting Engineer. Mr. Meserve's calculations show the inflow hydrographs for the east and west lakes were calculated by using Clark's unitgraph with parameters of Tc = 2.0 hours and R = 2.0 hours. The inflows were calculated based on a rainfall of 50 percent of the 6-hour probable maximum precipitation or 13.0 inches in 6 hours. The assumption was made that 100 percent of the precipitation ran off.

With the design infows calculated for each lake as indicated above, the peak inflows for the east and west lakes were determined to be 3,181 cfs and 5,709 cfs respectively. A peak inflow of 8,859 cfs for 50 percent of the probable maximum flood, referred to as the "spillway design flood (SDF)" in the calculations, was routed through the reservoirs. To determine outflow discharges for the reservoirs the discharge ratings for the spillways and outlets were calculated individually. Discharges for the twelve 11 by 6 feet box culverts of the west dam spillway were calculated by use of the broad-crested weir equation:

$$Q = CLH^{1.5}$$

C = 2.6, L = 132 feet, H = head on weir

To force the majority of the outflow from the two reservoirs to discharge through the east dam drop inlet, twelve 11 by 1 by 1 foot blocks were placed at the inverts of the west dam spillway box culverts to prevent flow in the west spillway unless inflows resulted in the lake levels exceeding an elevation 1 foot higher than the drop inlet elevation. The rating curve for the west spillway was changed only by using the same discharges calculated previously and increasing the corresponding elevations by 1 foot. The resulting design discharge capacity with the reservoir level at the top of dam for the west dam spillway box culverts was calculated at 9,270 cfs. The east dam drop inlet yielded a design discharge capacity with the reservoir level at the top of dam of 1,010 cfs by calculating the controlling discharge in the 6 by 5 feet inlet discharge culvert through the dam using the equation:

$$Q = A\,(2gH)^{0.5}$$

A = 30 sq ft, g = 32.2 ft/sec^2, H = 17.8 feet

When the inlet discharge culvert was not flowing full, at El.865.0 or below, the discharge was controlled by the equation:

$$Q = CLH^{1.5}$$

C = varied from 4.0 to 1.9 depending on the head on the weir
L = 27.5 feet, H = head on the weir up to 8 feet at El.865.0

An emergency spillway was designed for the west abutment of the east dam. The design discharges for the east dam emergency spillway were calculated using the equation:

$$Q = CLH^{1.5}$$

C = 3.52, L = 40 feet, and H = head on the weir

The design discharge at the top of dam was 1,570 cfs. The combined design outlet discharge at the top of dam was determined to be 11,850 cfs. At the design freeboard of 6 feet below top of dam (El.863.0) the design discharge capacity would total 3,540 cfs. The hydraulic effect of the boat channel connecting the two reservoirs was considered negligible in determining the hydraulics of the reservoirs. The boat channel did, however, provide justification for combining the hydraulic information of the two reservoirs to act as a single reservoir where lake elevations exceeded the invert of the boat channel (El.843.0).

b. Experience Data. The drainage area and lake surface area are developed from USGS Lees Summit and Lake Jacomo, Missouri Quadrangle Maps. The spillway and dam layout are from drawings provided by Andes and Roberts Construction Company.

c. Visual Observations.

(1) The drop inlet spillway, discharge outlet, and the spillway discharge channel are in good condition. The emergency spillway appears in good condition.

(2) Drawdown facilities are available to lower the pool to an elevation equivalent to the boat channel invert (El.843.0) (see paragraph 3.1c).

(3) The drop inlet spillway and discharge culvert are located near the north abutment. Spillway releases should not endanger the integrity of the dam.

d. Overtopping Potential. The spillway will pass the probable maximum flood (19,600 cfs), which is the spillway design flood recommended by the guidelines, without overtopping. The probable maximum flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. Failure of the Lakewood (West) Dam is not anticipated to pose a serious hazard to the Lakewood (East) Dam

due to the maximum drawdown from normal pool level being restricted to 15 feet by the boat channel invert (El.843.0). Failure of upstream water impoundments shown on the 1975 revised USGS map would not have a significant impact on the hydrologic or hydraulic analysis as the storage of these reservoirs was not considered. However the effect of total failure of these dams has not been investigated.

According to the St. Louis District, Corps of Engineers, the estimated damage zone extends 20 miles downstream of the dam. Within the first mile of the damage zone are six homes and the bridge of one improved road. The flood plain is farmed.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visual observations of conditions which affect the structural stability of this dam are discussed in Section 3, paragraph 3.1b.

b. Design and Construction Data. No design data relating to the structural stability of the dam were found.

c. Operating Records. No operational records exist.

d. Post Construction Changes. No post construction changes exist which will affect the structural stability of the dam.

e. Seismic Stability. The dam is located in Seismic Zone 1 which is a zone of minor seismic risk. A properly designed and constructed earth dam using sound engineering principles and conservatism should pose no serious stability problems during earthquakes in this zone.

The seismic stability of an earth dam is dependent upon a number of factors: The important factors being embankment and foundation materials and shear strengths; abutment materials, conditions, and strength; embankment zoning; and embankment geometry. Adequate descriptions of embankment design parameters, foundation and abutment conditions, or static stability analyses to assess the seismic stability of this embankment were not available and therefore no inferences will be made regarding the seismic stability. An assessment of the seismic stability should be included as a part of the stability analysis required by the guidelines.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. Several items were noted during the visual inspection by the inspection team which should be monitored or controlled. Erosion of the downstream toe of the embankment, vegetal growth on the downstream slope, and seepage at the right abutment are of concern.

b. Adequacy of Information. Due to the unavailability of engineering design data on the embankment and the absence of seepage and stability analyses, the conclusions in this report were based on performance history, review of drawings, hydrologic/hydraulic calculations, and construction information, and visual conditions. The inspection team considers that these data are sufficient to support the conclusions herein. However, seepage and stability analyses comparable to those required in the guidelines are necessary to satisfy the requirements of the guidelines.

c. Urgency. A program should be developed as soon as possible to monitor at regular intervals the deficiencies described in this report. The remedial measures recommended in paragraph 7.2 could be accomplished now or delayed until observations of this monitoring program and/or the recommendation of a qualified engineer indicate the necessity for action. If the safety deficiencies listed in paragraph 7.1a are not corrected, they are anticipated to continue to deteriorate and lead to a serious potential of failure. Presently, immediate action is not considered necessary.

d. Necessity for Phase II. The Phase I investigation does not raise any serious questions relating to the safety of the dam or identify any serious dangers that would require a Phase II investigation.

e. Seismic Stability. This dam is located in Seismic Zone 1. Because stability analyses are not available, the seismic stability of the dam cannot be assessed. An assessment of the seismic stability should be included as part of the stability analysis required by the guidelines.

7.2 REMEDIAL MEASURES

a. Alternatives. No measures are recommended.

b. O&M Maintenance and Procedures. The following O&M maintenance and procedures are recommended:

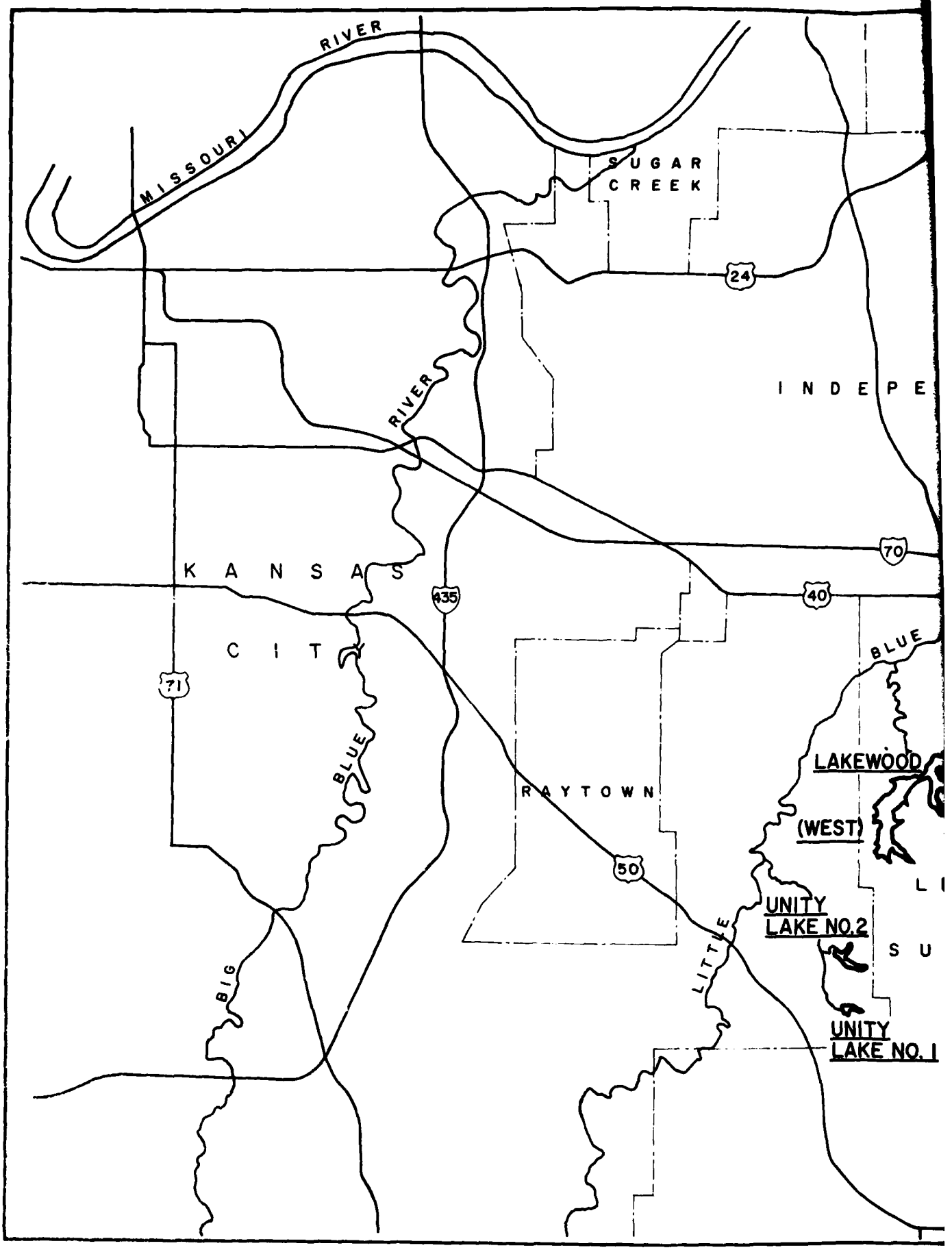
(1) Check the downstream face of the dam periodically for seepage and stability problems. If increased seepage flows are observed or deterioration of the foundations of the embankment noted, the dam should be inspected and the pending condition evaluated by an engineer experienced in design and construction of earthen dams.

(2) Measures to prevent further erosion of the downstream toe of the embankment should be undertaken.

(3) A regular maintenance program should be initiated to control the growth on downstream slope of the dam.

(4) A detailed inspection of the dam should be made at least every year by an engineer experienced in design and construction of dams. More frequent inspections may be required if items of distress are observed other than those already mentioned.

(5) Seepage and stability analyses should be performed by a professional engineer experienced in the design and construction of dams.


MISSOURI RIVER
SUGAR CREEK
24
INDEPE
RIVER
70
KANSAS
435
40
CIT
BLUE
71
BLUE
LAKEWOOD
RAYTOWN
(WEST)
50
UNITY
LAKE NO.2
LITTLE
BIG
UNITY
LAKE NO. 1

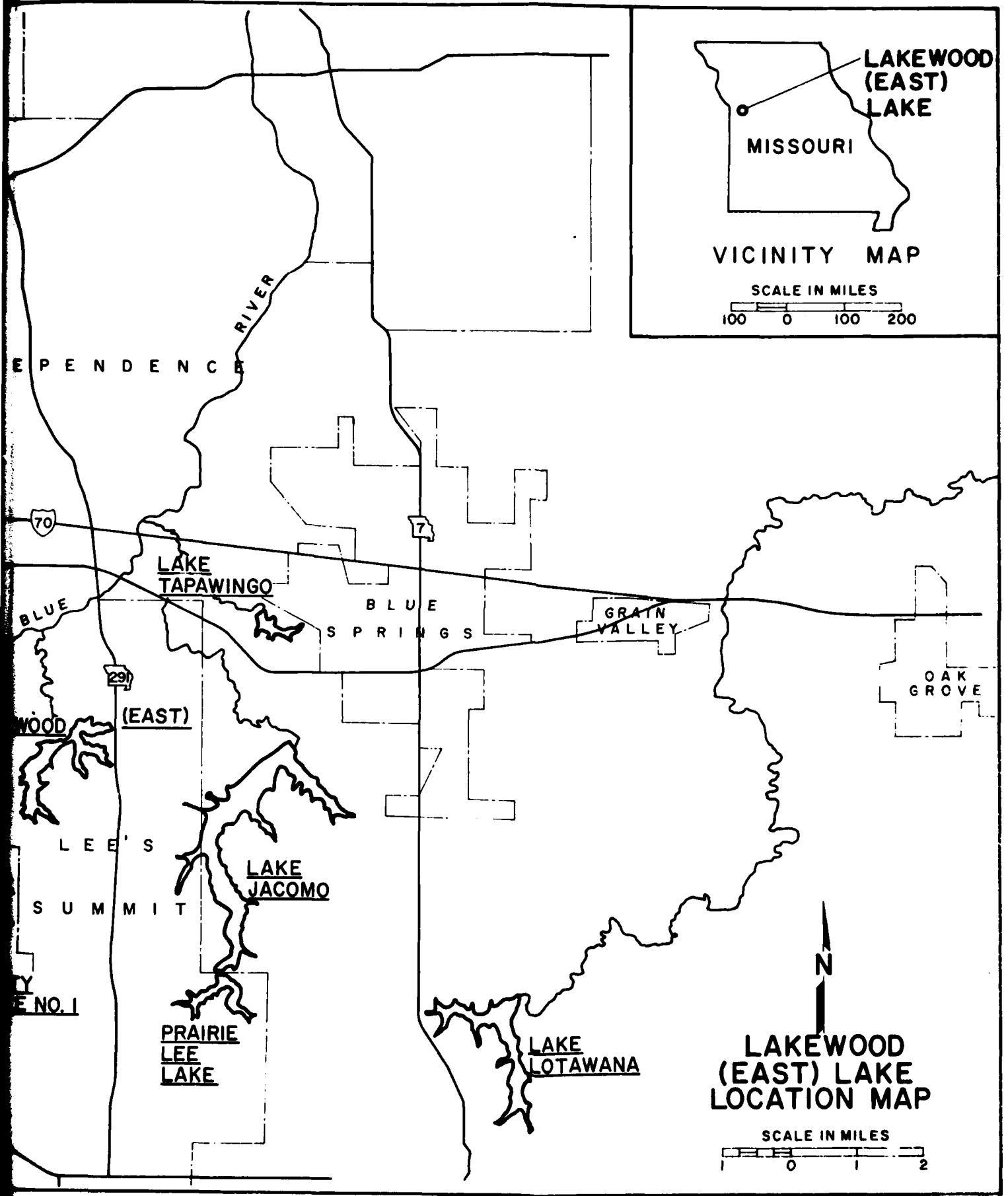

LAKEWOOD (EAST) LAKE
MISSOURI
VICINITY MAP
SCALE IN MILES
100 0 100 200
EPENDENCE
RIVER
70
7
LAKE TAPAWINGO
BLUE
BLUE SPRINGS
GRAIN VALLEY
OAK GROVE
291
(EAST)
LEE'S SUMMIT
LAKE JACOMO
PRAIRIE LEE LAKE
LAKE LOTAWANA
N
LAKEWOOD (EAST) LAKE LOCATION MAP
SCALE IN MILES
1 0 1 2

PLATE 1

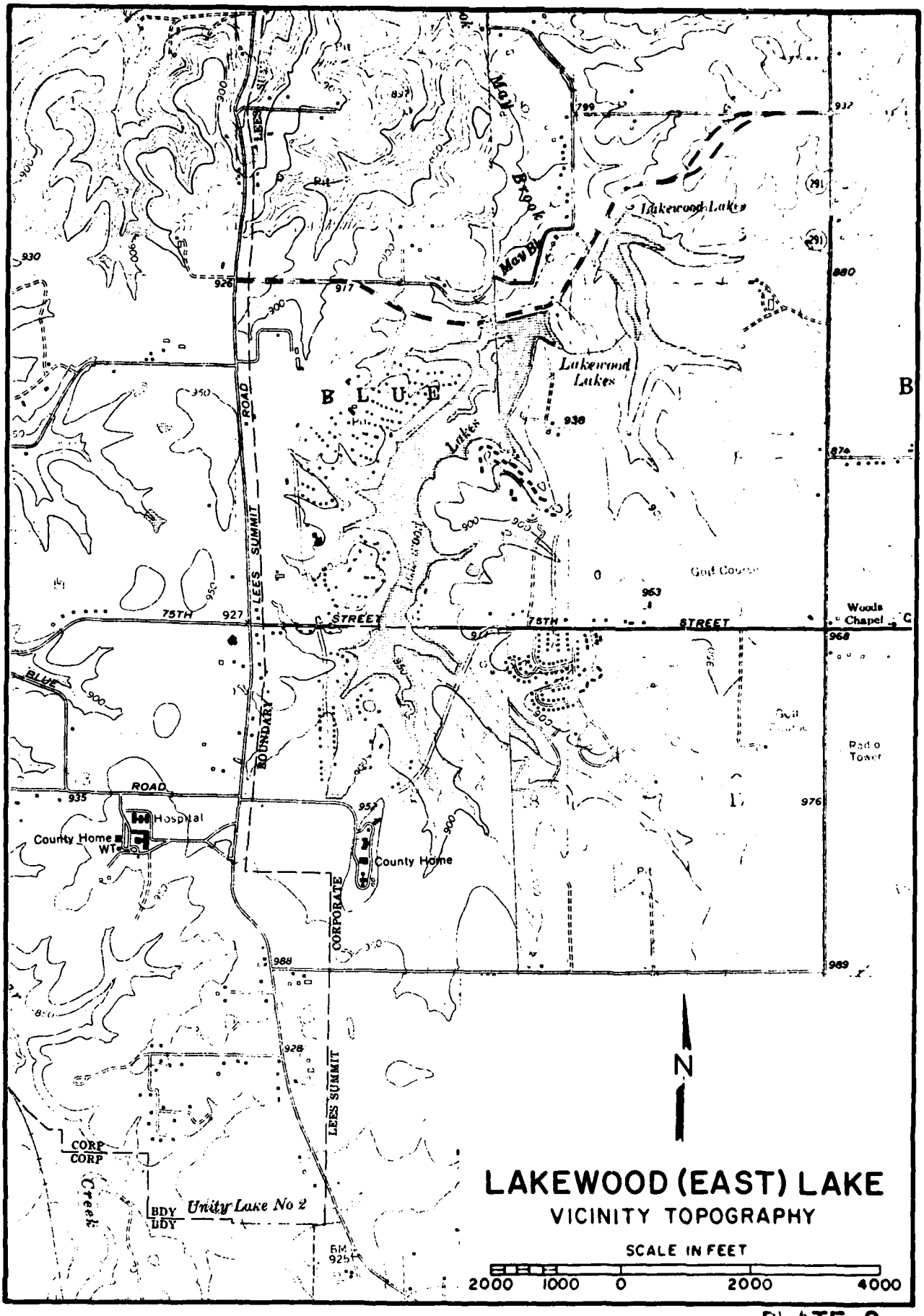
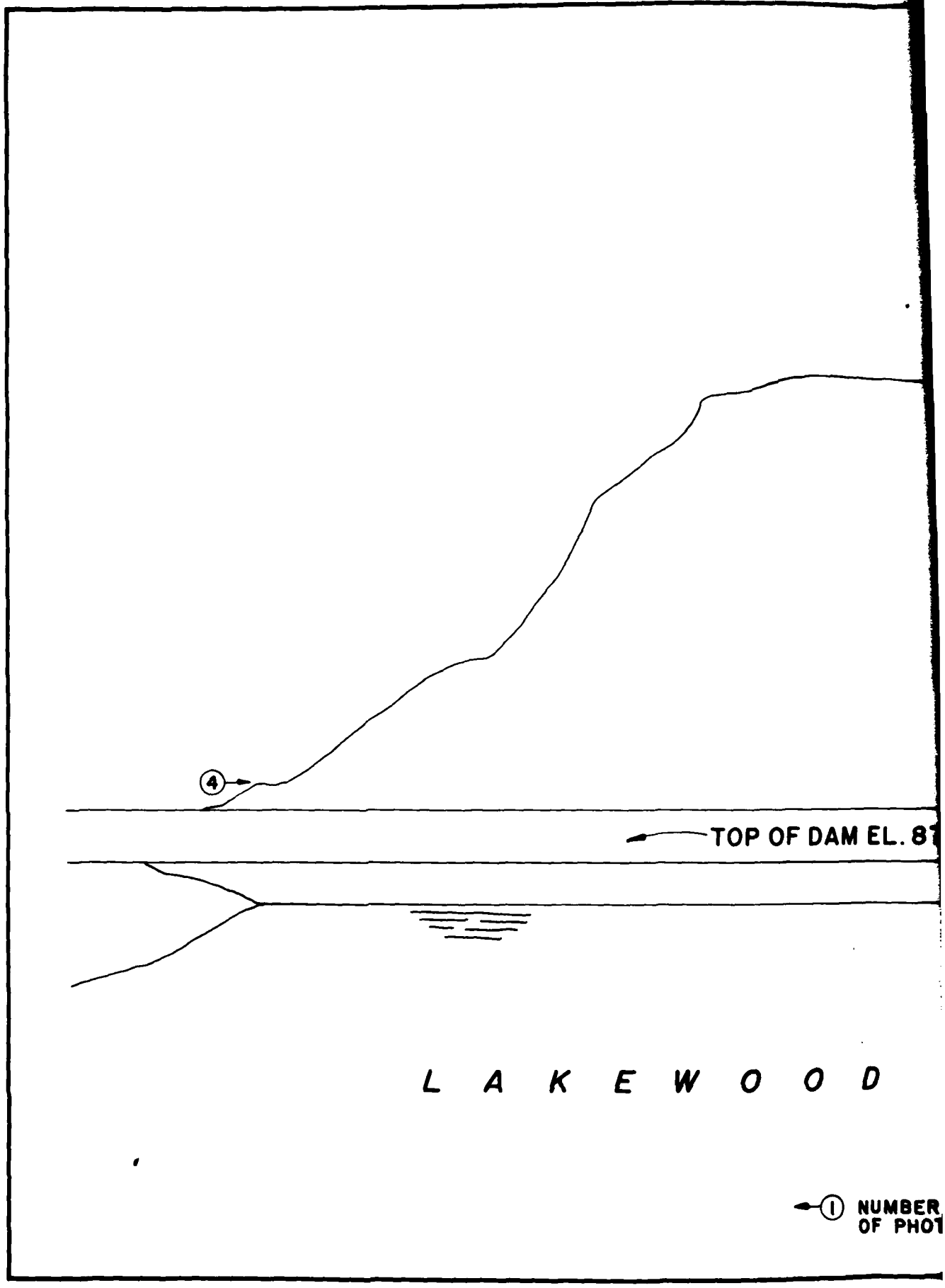
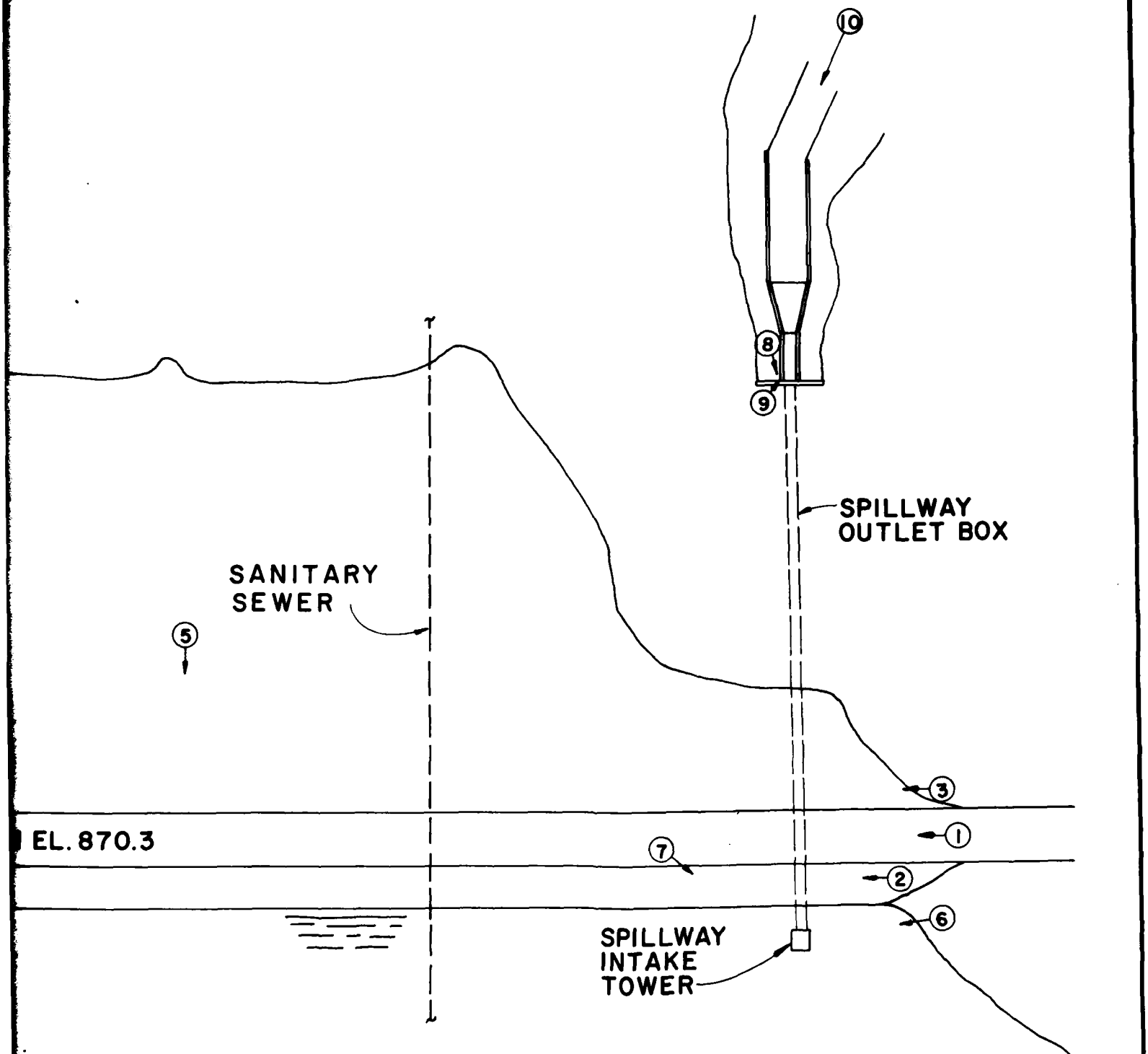

LEES SUMMIT ROAD
BOUNDARY
CORPORATE
75TH STREET
BLUE
Lakewood Lakes
May Brook
Golf Course
Woods Chapel
Radio Tower
Hospital
County Home
County Home WT
Unity Lake No 2
CORP
BDY
Creek
N
LAKEWOOD (EAST) LAKE
VICINITY TOPOGRAPHY
SCALE IN FEET
2000 1000 0 2000 4000

PLATE 2


4
TOP OF DAM EL. 8
L A K E W O O D
1 NUMBER
OF PHO



D (E A S T) L A K E

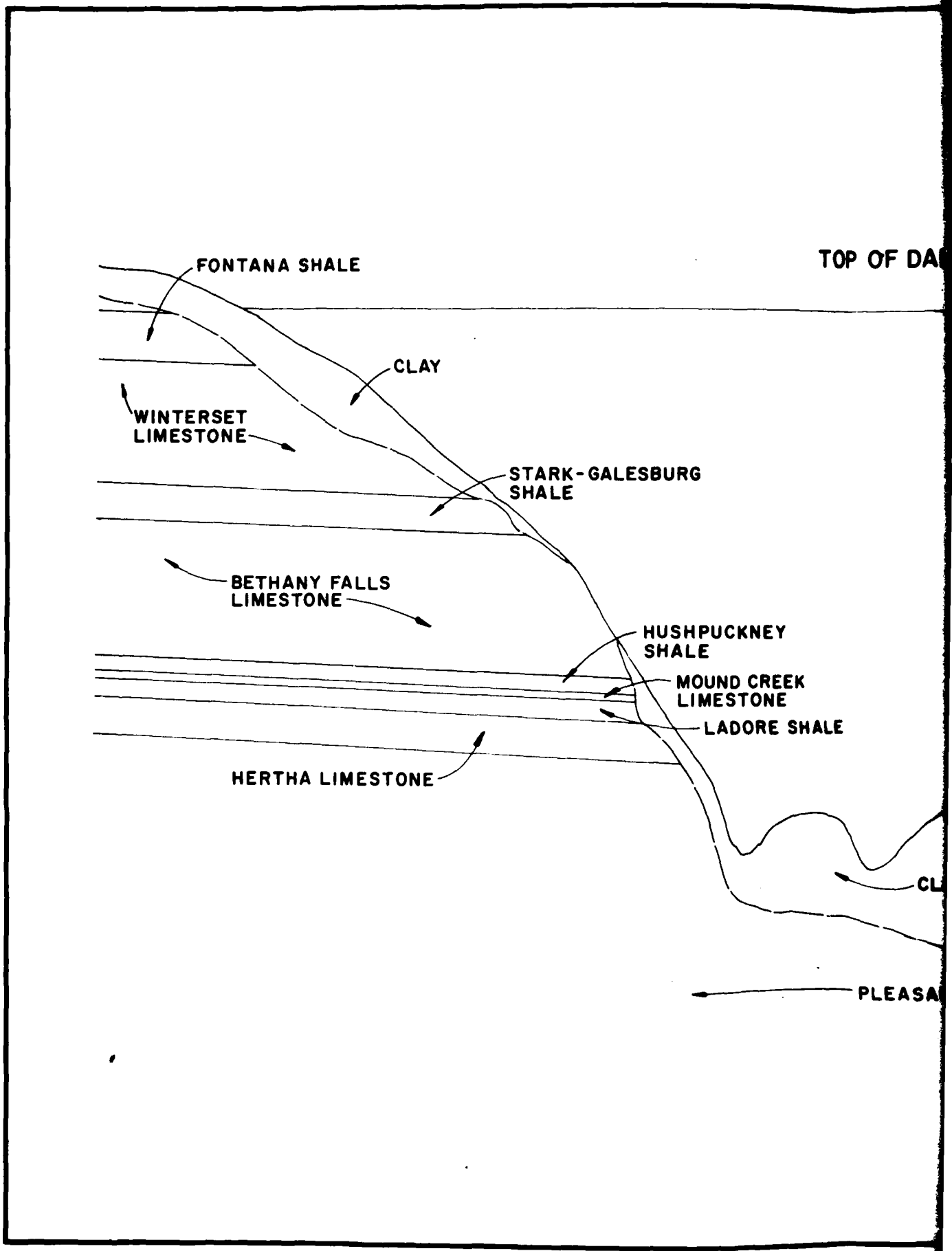
NUMBER & DIRECTION
OF PHOTOGRAPH

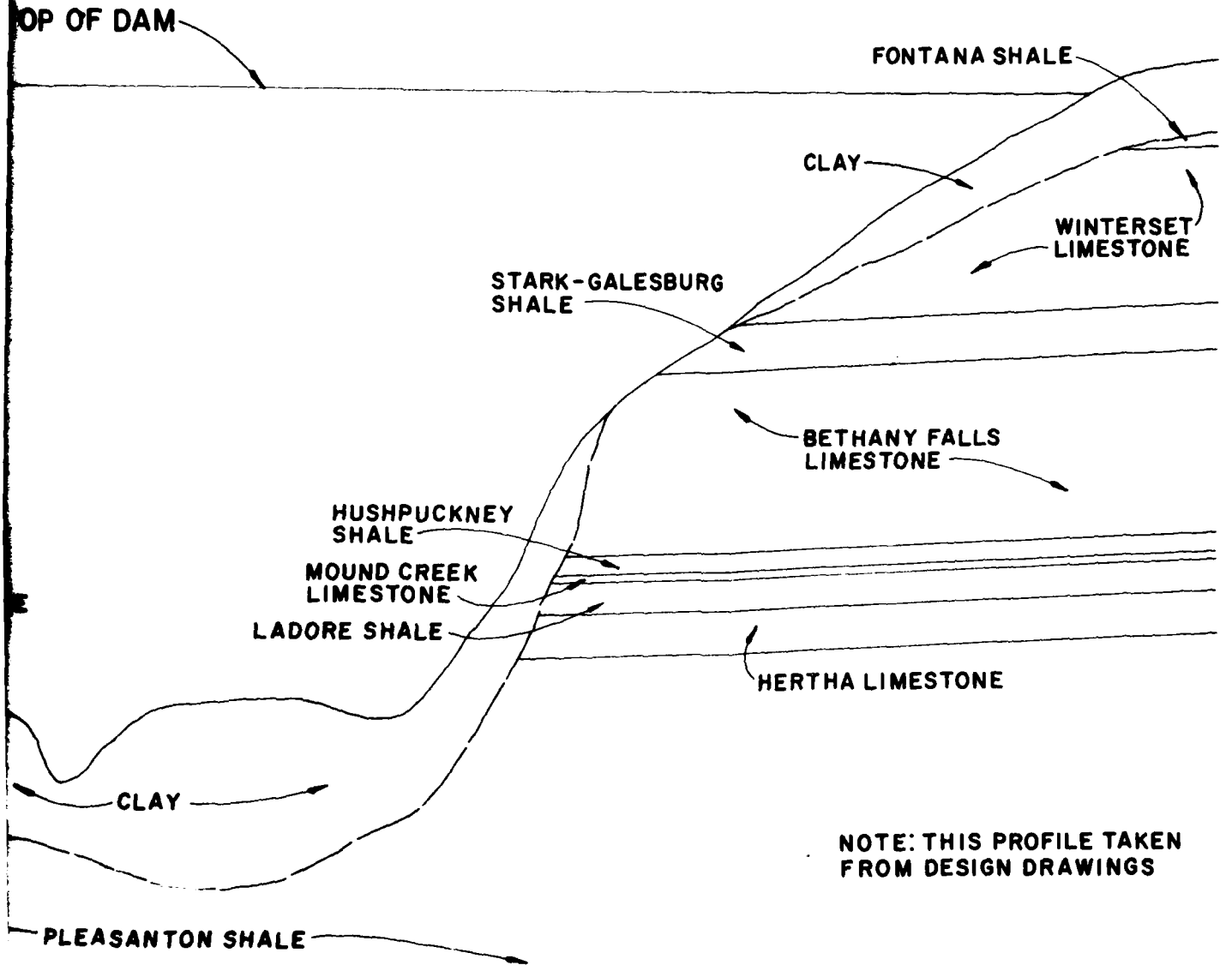
0 100 200
SCALE IN FEET

LAKEWOOD (EAST) LAKE PLAN

PLATE 3

1 2

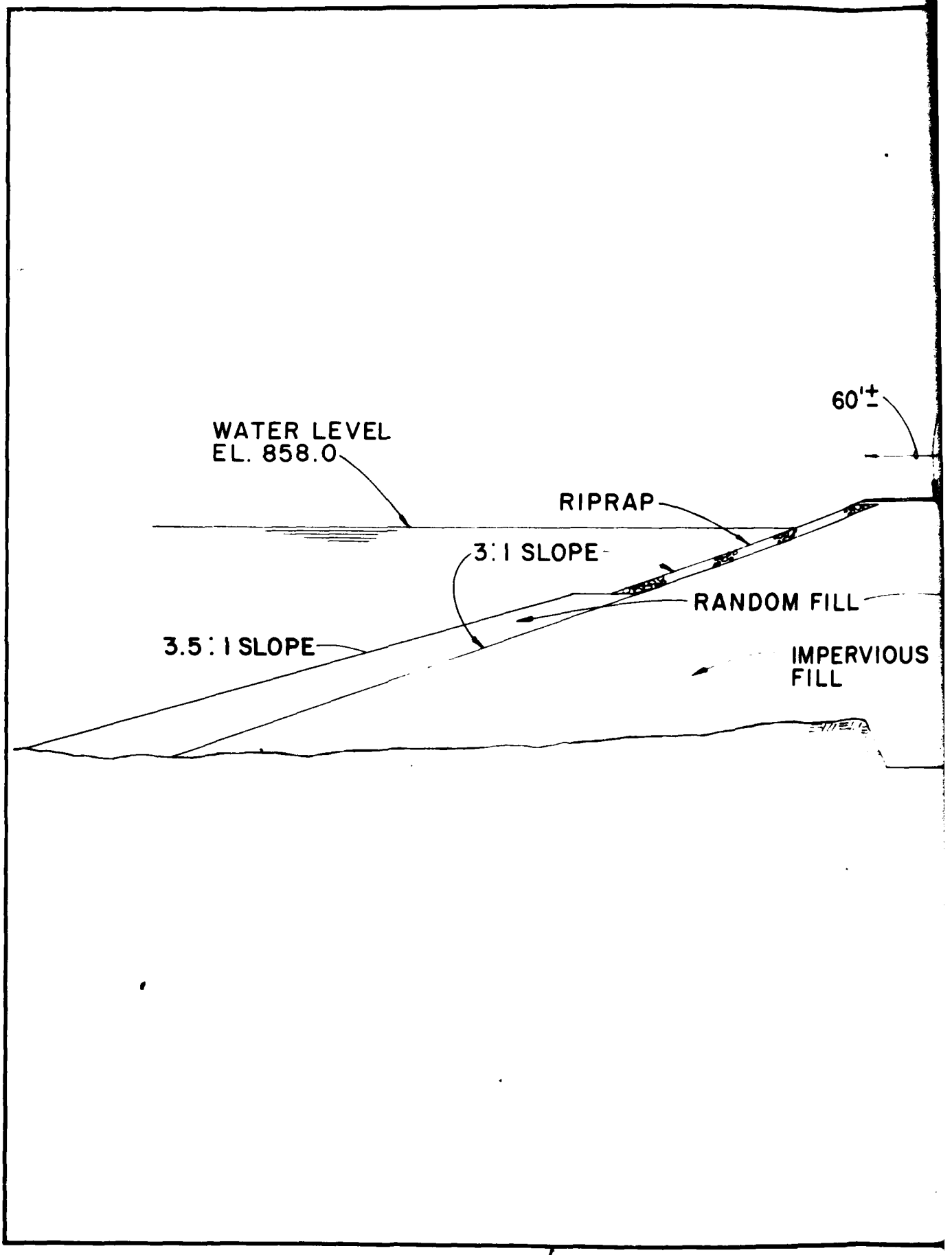

FONTANA SHALE
TOP OF DA
CLAY
WINTERSET
LIMESTONE
STARK-GALESBURG
SHALE
BETHANY FALLS
LIMESTONE
HUSHPUCKNEY
SHALE
MOUND CREEK
LIMESTONE
LADORE SHALE
HERTHA LIMESTONE
CL
PLEASA

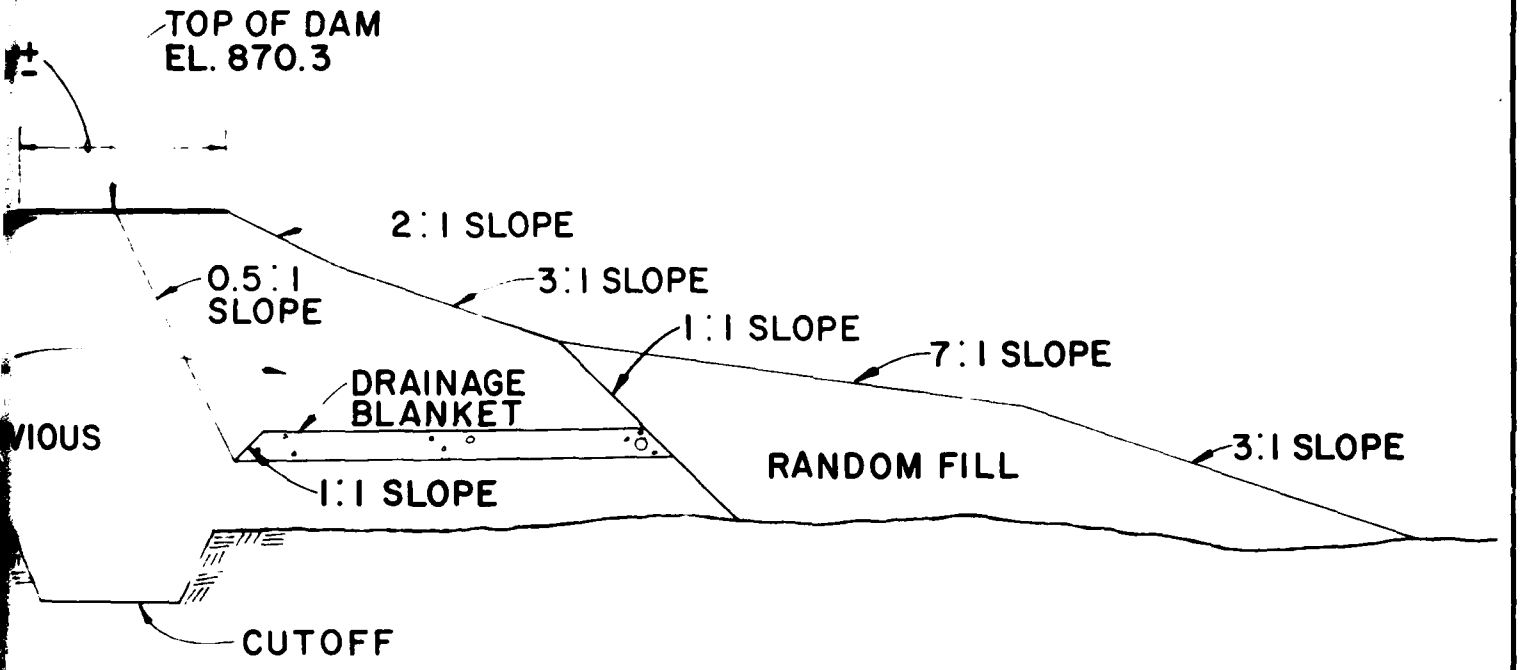


NOTE: THIS PROFILE TAKEN FROM DESIGN DRAWINGS

LAKEWOOD (EAST) LAKE PROFILE

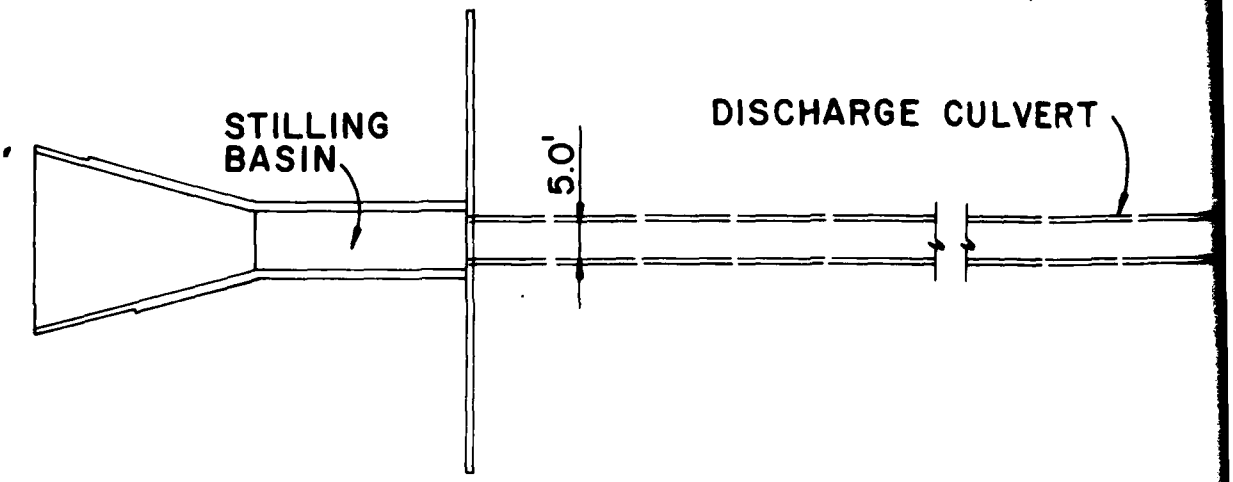
PLATE 4


60'±
WATER LEVEL
EL. 858.0
RIPRAP
3:1 SLOPE
RANDOM FILL
3.5:1 SLOPE
IMPERVIOUS
FILL

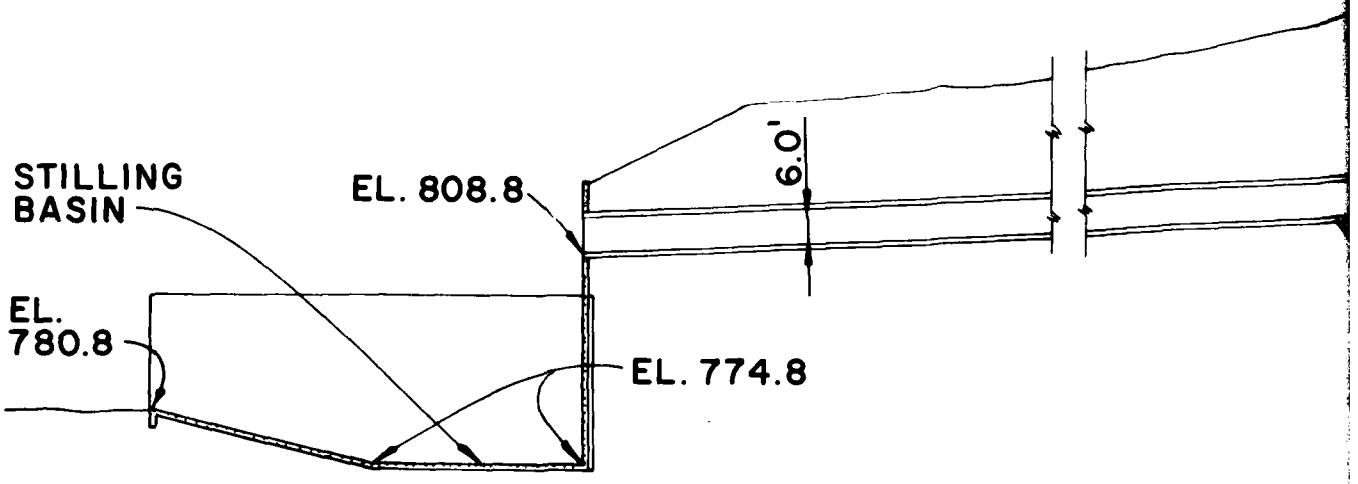


LAKEWOOD (EAST) LAKE
TYPICAL SECTION

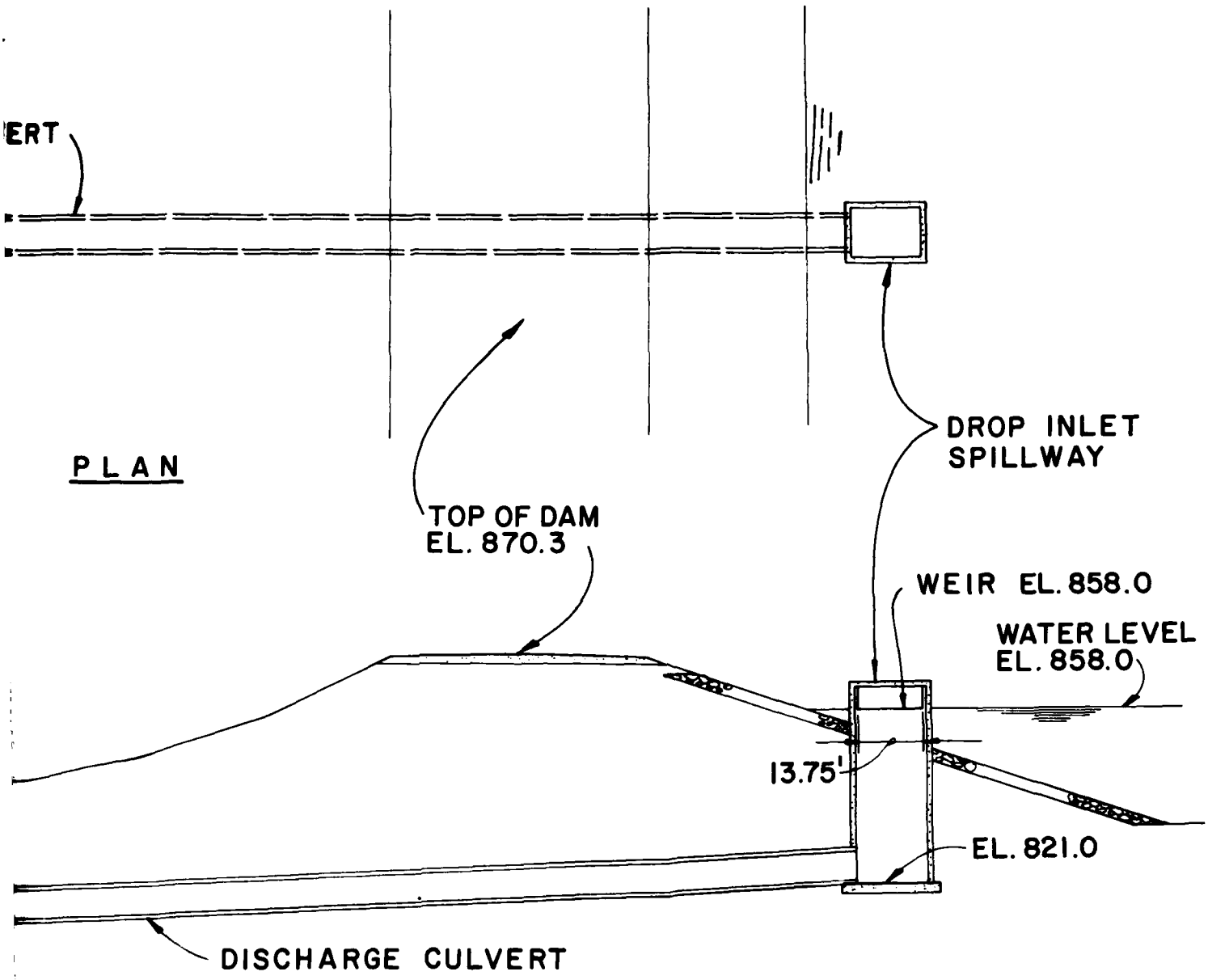
PLATE 5


STILLING
BASIN
5.0'
DISCHARGE CULVERT

PLA


STILLING
BASIN
EL. 808.8
6.0'
EL.
780.8
EL. 774.8

SECTI

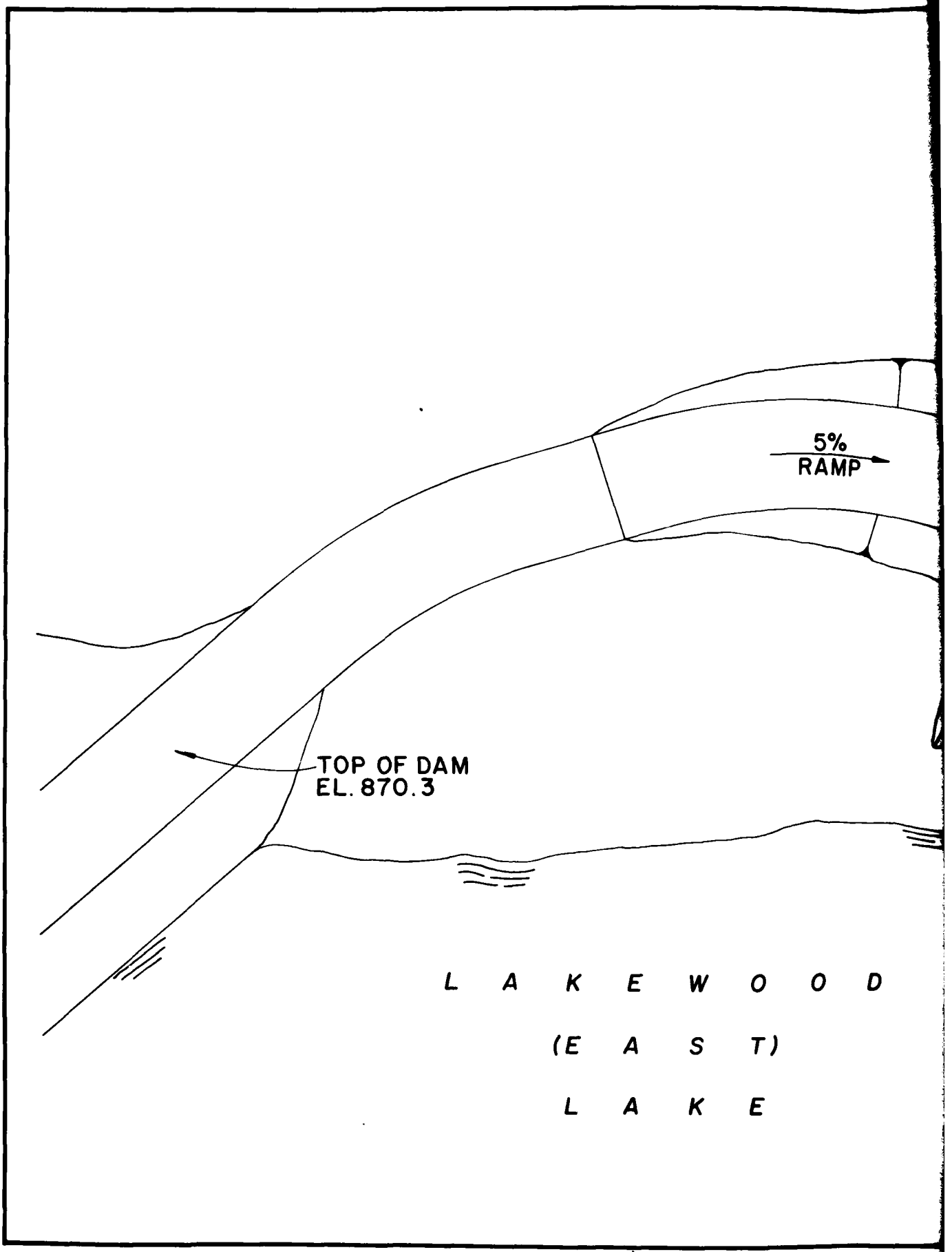


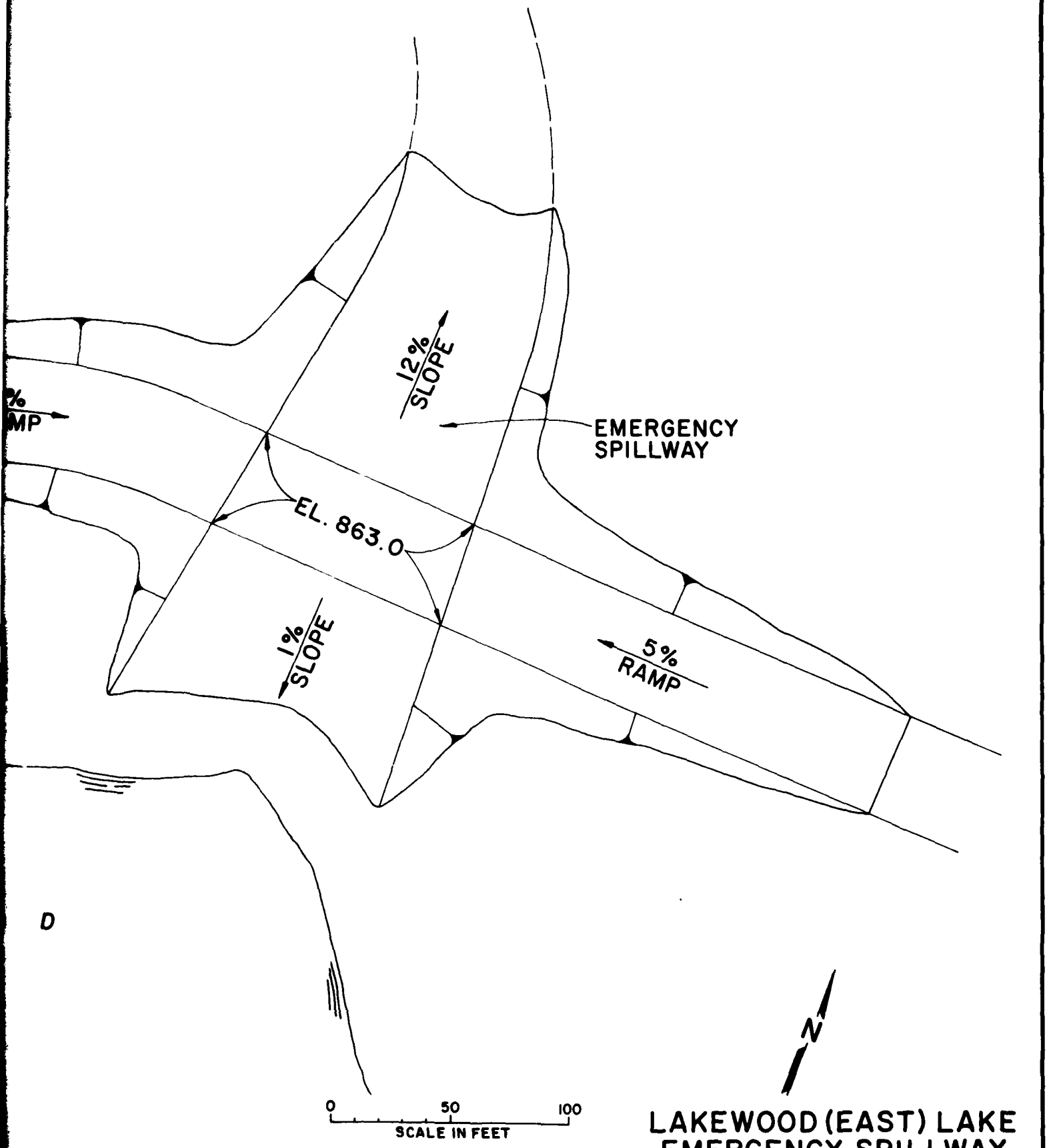
SECTION

LAKEWOOD (EAST) LAKE
DROP INLET SPILLWAY

PLATE 6

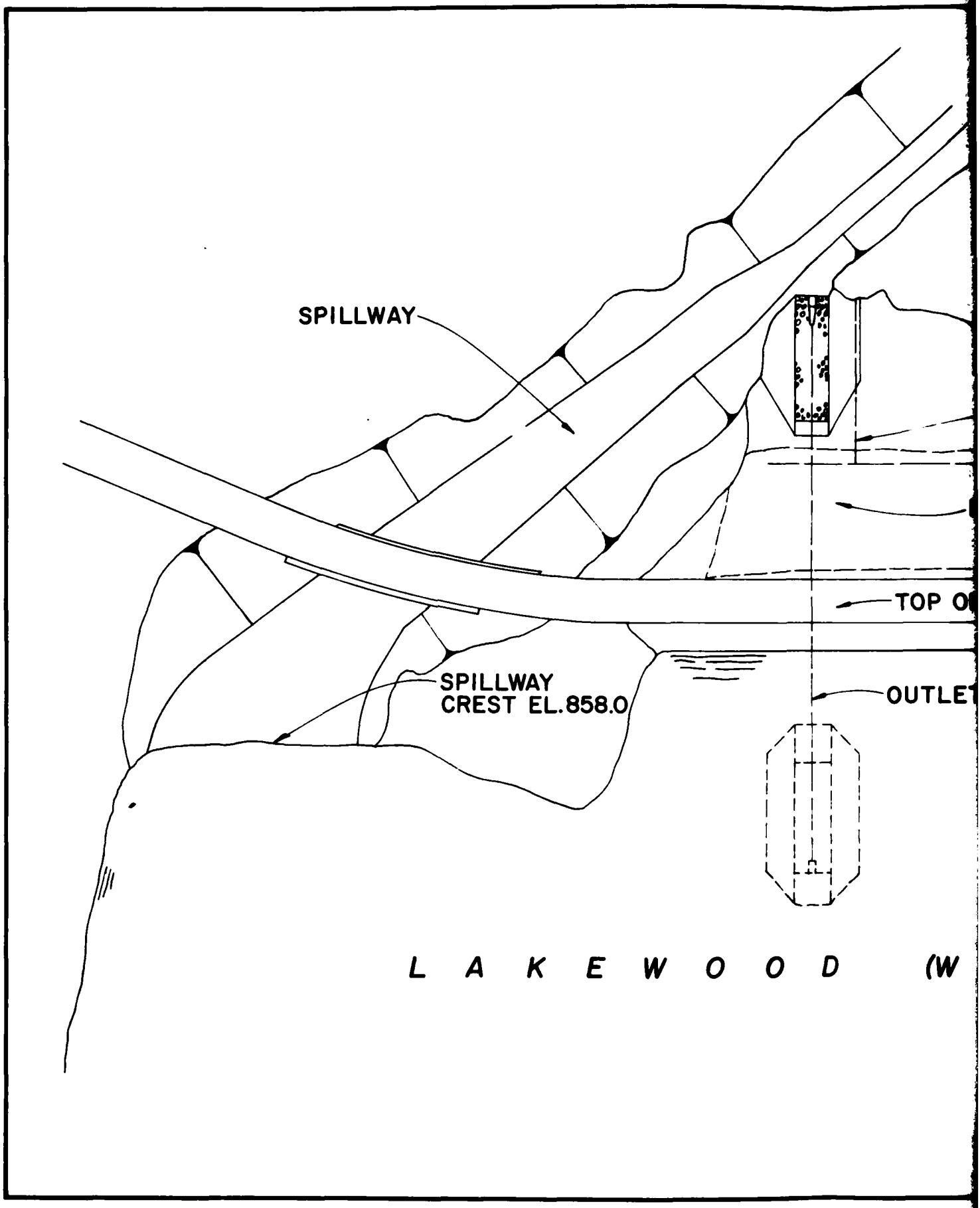
1 2

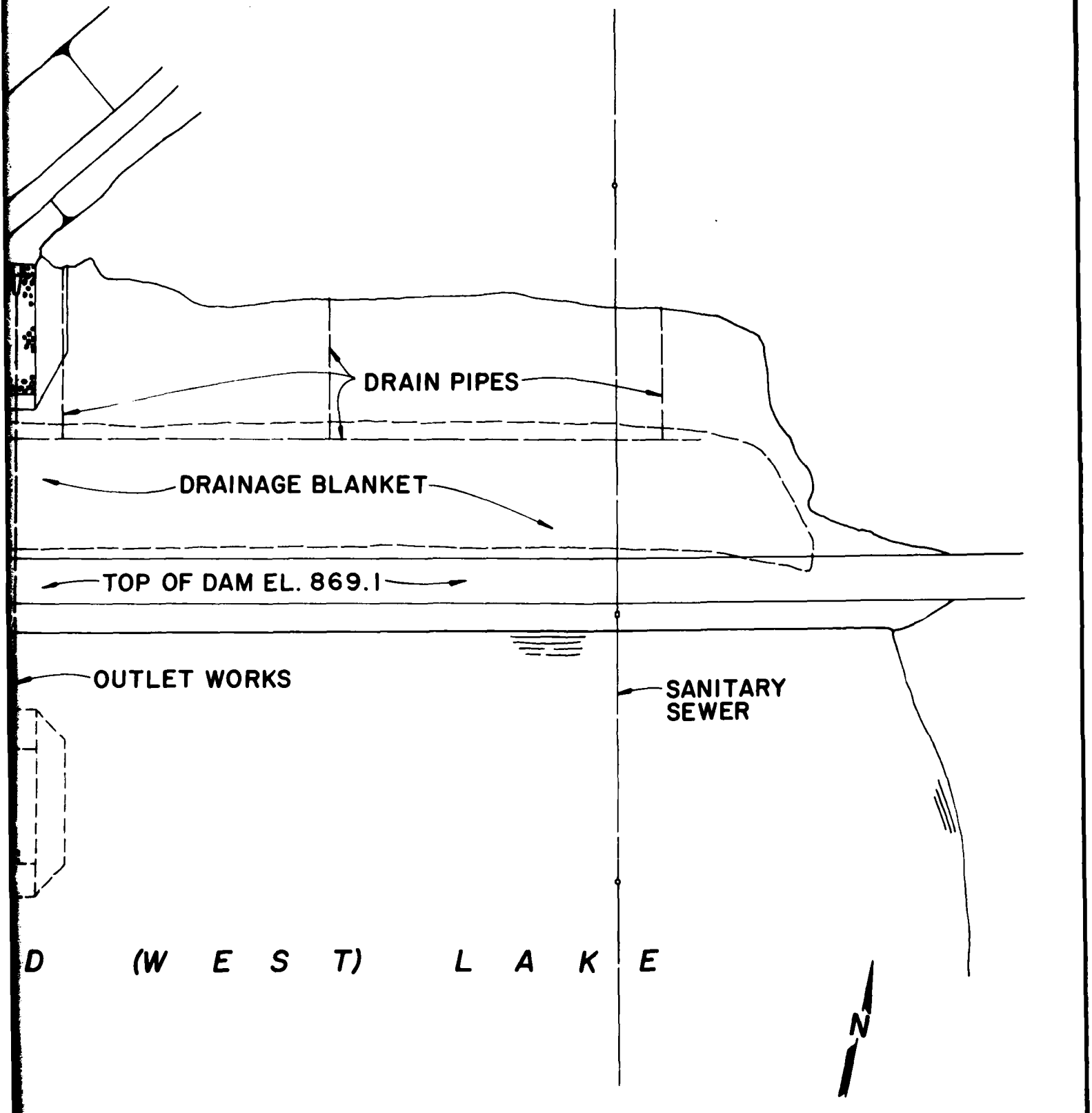

5%
RAMP
TOP OF DAM
EL. 870.3
L A K E W O O D
(E A S T)
L A K E



LAKEWOOD (EAST) LAKE
EMERGENCY SPILLWAY

PLATE 7


SPILLWAY
TOP O
SPILLWAY
CREST EL.858.0
OUTLE
L A K E W O O D (W



LAKEWOOD (WEST) LAKE PLAN

PLATE 8

1 2

PHOTO NO. 1: OVERVIEW OF LAKE

PHOTO NO. 2: TOP OF DAM

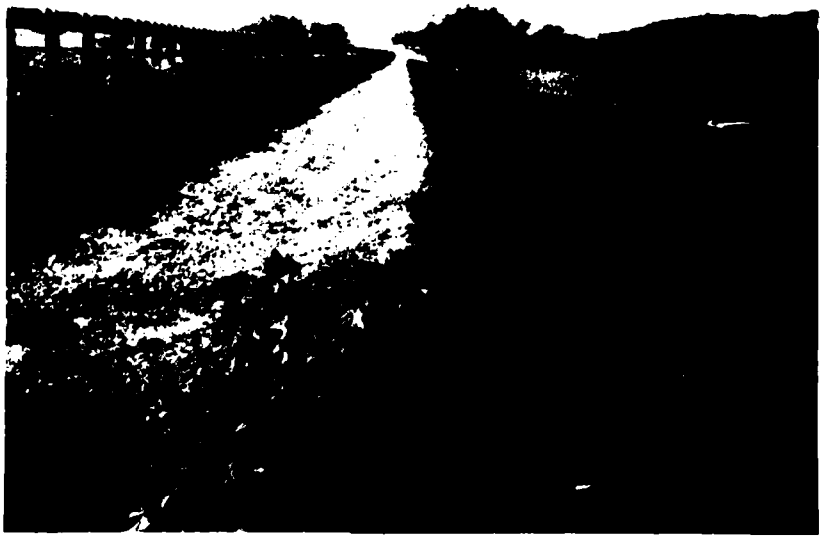


PHOTO NO. 3: LOCATION OF NEWLY PLACED WATER LINE ON DOWNSTREAM FACE(Looking South)

PHOTO NO. 4: DOWNSTREAM FACE OF DAM (Looking North)

PHOTO NO. 5: DOWNSTREAM FACE OF DAM(Looking Upstream)

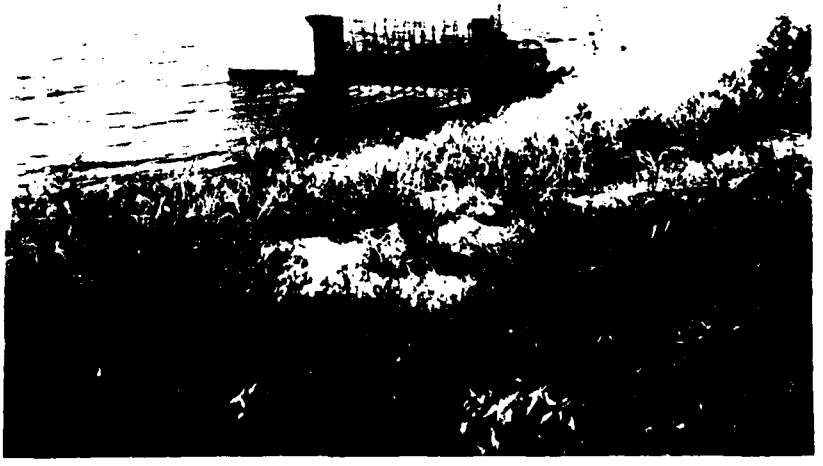


PHOTO NO. 6: UPSTREAM FACE OF DAM AND DROP INLET SPILLWAY (Looking South)

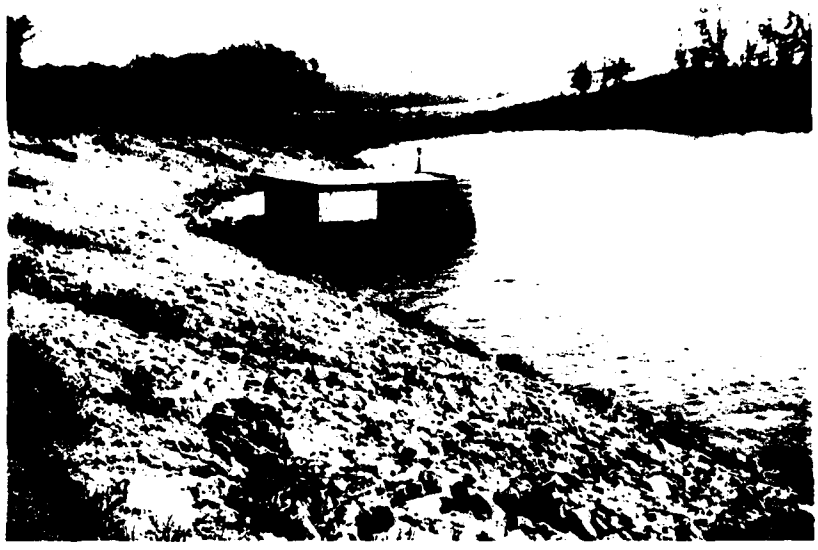


PHOTO NO. 7: DROP INLET SPILLWAY, EMERGENCY SPILLWAY, AND NORTH ABUTMENT (Looking North)

PHOTO NO. 8: DROP INLET DISCHARGE OUTLET (Looking Upstream)

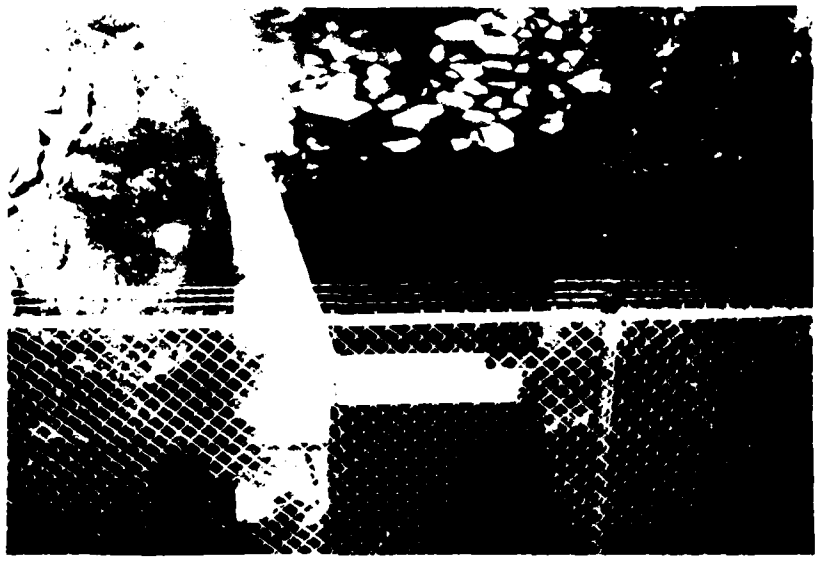


PHOTO NO. 9: STILLING BASIN IMMEDIATELY DOWNSTREAM OF DROP INLET DISCHARGE OUTLET(Looking Downstream)

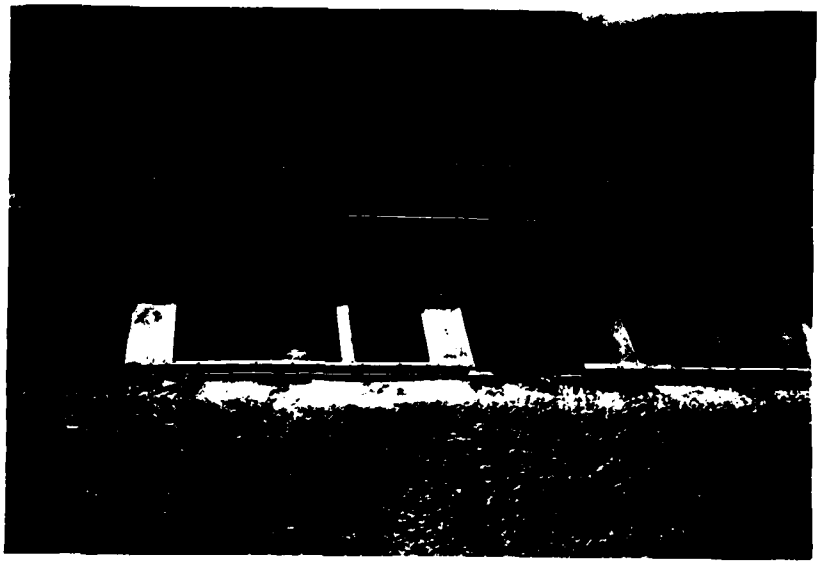


PHOTO NO. 10: DISCHARGE CHANNEL DOWNSTREAM OF DROP INLET DISCHARGE OUTLET(Looking Upstream)

APPENDIX A

HYDROLOGIC COMPUTATIONS

HYDROLOGIC COMPUTATIONS

1. The Soil Conservation Service (SCS) dimensionless unit hydrograph and HEC-1 (1) were used to develop the inflow hydrograph (see Plate A-1) and hydrologic inputs are as follows:

a. Twenty-four hour, probable maximum precipitation determined from U.S. Weather Bureau Hydrometeorological Report No. 33:

200 square mile, 24 hour rainfall	- 24.8 inches
10 square mile, 6 hour percent of 24 hour 200 square mile rainfall	- 101%
10 square mile, 12 hour percent of 24 hour 200 square mile rainfall	- 120%
10 square mile, 24 hour percent of 24 hour 200 square mile rainfall	- 130%

b. Drainage area = 3,410 acres
(2,210 acres, West Lake + 1,200 acres, East Lake)

c. Time of concentration: $Tc = (11.9 \times L^3/H)^{0.385}$ = 18 minutes (East Lake), 47 minutes (West Lake) (L = length of longest watercourse in miles, H = elevation difference in feet) (2)

d. Losses were determined in accordance with SCS methods for determining runoff using a curve number of 76 and antecedent moisture condition III.

2. The spillway release rates for the box culverts on the west dam were determined by using the equation:

$Q = wg^{0.5}(H/1.5)^{1.5}$
w = 132 feet (net width of box culverts),
H = head above the box culvert invert

When the reservoir elevation rose over the top of road over the box culverts, additional discharge was determined using the broadcrested weir equation:

$Q = CLH^{1.5}$
C = 2.6, L = variable length of weir in feet, H = head on the weir (above the top of road elevation)

Releases from the drop inlet spillway of the east dam were calculated by using:

$$Q = CLH^{1.5}$$

C = 2.98 to 3.32, L = 27.5 feet, H = head on inlet weir.

The drop inlet discharge culvert controlled the flow from the inlet where the reservoir level exceeded El.862.0. At this point the discharge was calculated by using the equation:

$$Q = 119.03h_L^{0.5}$$

h_L = head measured from the top of the discharge culvert to the reservoir elevation.

The above equation was derived from:

$$h_L = K_b V^2/2g + n^2V^2L/2.22R^{1.33} + V^2/2g$$

K_b = 1.5, n = 0.018, L = 256 feet, R = 1.36 feet using an area of 30 sq. ft. for the discharge culvert

Discharges from the east dam emergency spillway were determined from the equation:

$$Q = CLH^{1.5}$$

C = 3.087, L = varied length of weir in feet,
H = head on the weir in feet.

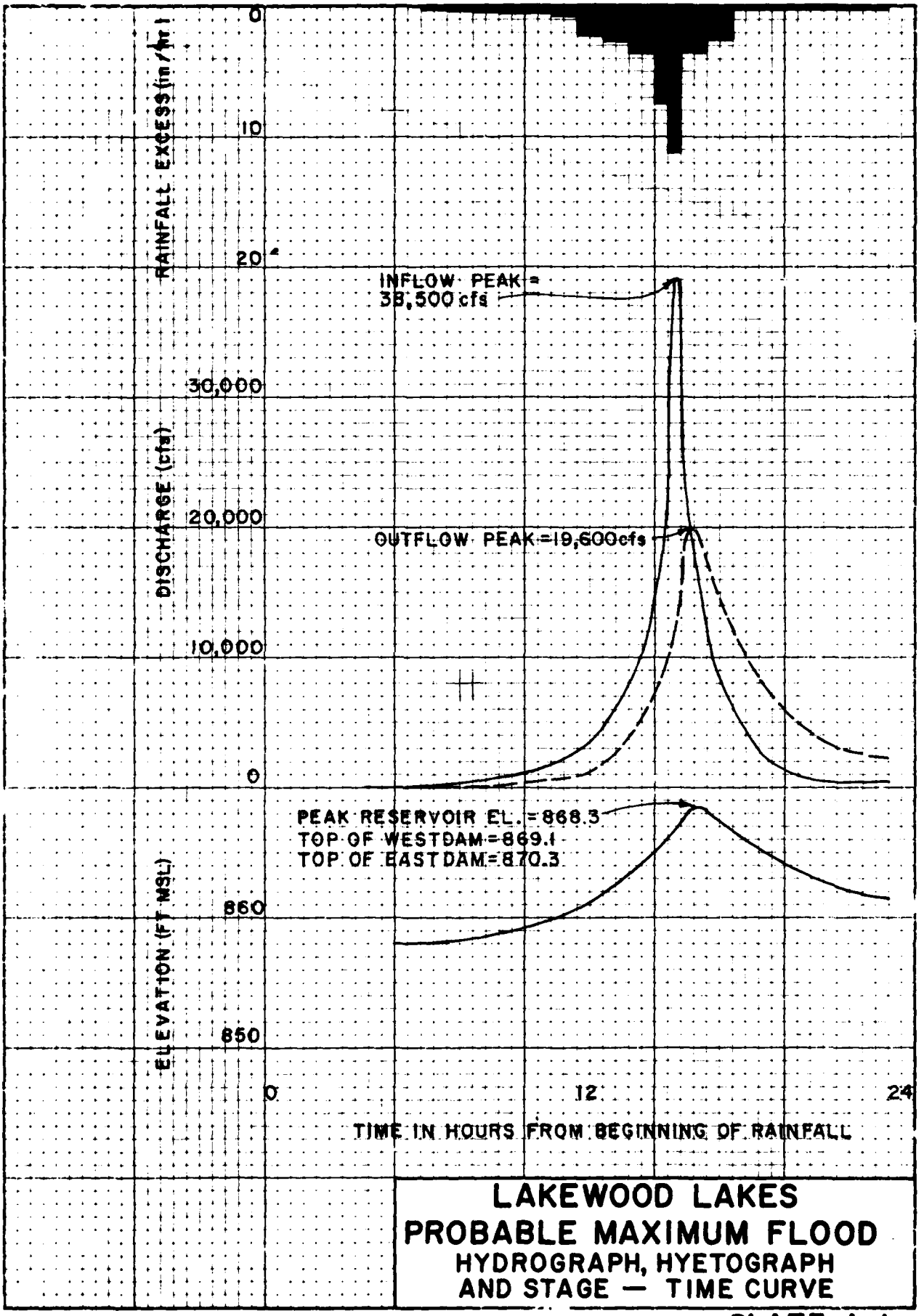
The discharges as calculated above were combined at their respective elevations to produce a discharge rating curve for the two interconnected reservoirs.

3. The elevation-storage relationship above normal pool elevation was constructed by planimetering the area enclosed within each contour above normal pool. The storage between two elevations was computed by multiplying the average of the areas at the two elevations by the elevation difference. The summation of these increments below a given elevation is the storage below that level.

4. Using HEC-1 the inflow hydrographs for the east and west reservoirs are computed, then the combined floods are routed through the spillway using modified Puls to determine the capability of the spillway. Inflow and outflow hydrographs are shown on Plate A-1.

(1) U.S. Army Corps of Engineers, Hydrologic Engineering Center, Flood Hydrograph Package (HEC-1), Dam Safety Version, July, 1978, Davis, California.

(2) U.S. Department of the Interior, Bureau of Reclamation, Design of Small Dams, 1974, Washington, D.C.



LAKEWOOD LAKES
PROBABLE MAXIMUM FLOOD
HYDROGRAPH, HYETOGRAPH AND STAGE — TIME CURVE

PLATE A-1